

**SNAKE SPECIES RICHNESS IN RELATION TO HABITAT IN
THE POST OAK SAVANNAH OF EAST CENTRAL TEXAS**

A Senior Scholars Thesis

by

JOHN W. PUTEGNAT

Submitted to the Office of Undergraduate Research

Texas A&M University

In partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2006

Major: Wildlife and Fisheries Sciences

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Approved:

Research Advisor: Kirk Winemiller

Associate Dean for Undergraduate Research: Robert C. Webb

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ABSTRACT

Snake species richness in relation to habitat in the post oak savannah of East Central
Texas (April 2006)

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This project examined snake species richness and relative abundances in a heterogeneous landscape within the post oak savannah of East Central Texas. Snakes were sampled using funnel traps (with drift fences for terrestrial species) and hand capture from April to August of 2005 at a 1295 hectare ranch managed for wildlife habitat. Ten sites were sampled within the following habitat categories: upland woodland, prairie, riparian forest, and ponds. A total of 184 individuals of 15 species were observed or captured. The most abundant species were the plain-bellied water snake (*Nerodia erythrogaster*), western ribbon snake (*Thamnophis proximus*), and eastern coachwhip (*Masticophis flagellum*). The least abundant species were the brown snake (*Storeria dekayi*), speckled kingsnake (*Lampropeltis getula*), and eastern coral snake (*Micrurus fulvius*). The timber rattlesnake (*Crotalus horridus*), a threatened

species, appears to have a viable population within the study area. Abundance and species richness varied according to each habitat, with riparian forest having highest collective abundance and species richness, and pond habitats yielding fewest individuals and species.

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CHAPTER I

INTRODUCTION¹

The habitat in which a snake prefers to live has environmental conditions and contains resources that suit its ecological needs. Habitats differ in multiple environmental characteristics including temperature, moisture, and cover. Physiological responses will vary according to habitat characteristics. The behavior and physiology are greatly influenced by elongated morphology and absence of limbs (Greene 1997). With ground-level being the most common habitat used by snakes, their sensory capability is rich in tactile, thermal, and chemical cues; however, the most essential sensory system is chemoreception. Relative concentrations of volatile molecules and the proximity and direction of potential prey, mates, or predators are detected via the snake's deeply forked tongue. Some snakes (i.e. pit vipers) possess pit organs that serve as infrared receptors which enable an individual to perceive its thermal environment. Snakes are ectothermic, which precludes them from producing excess metabolic heat to sustain body temperature above ambient temperature. Therefore, the amount of sunlight penetrating through vegetation to the ground is an important aspect of habitat selection. The differences in canopy density and cover among habitat types will dictate the amount of solar radiation, humidity, ground moisture, and temperature within the given habitat. The objectives of

¹ This thesis follows the style and format of *The Southwestern Naturalist*.

this study are to determine if a relationship exists between species richness and habitat and to test the theory that larger individuals are active at lower temperatures.

The major habitat disturbance affecting snakes is human development and pollution (Werler and Dixon 2000). Habitat fragmentation interrupts the natural routes traveled by snakes; more importantly, certain types of habitat are developed more often than others (i.e. upland woodlands). Snakes and other wildlife that rely on a particular type of habitat suffer losses. Displaced snakes are then subject to using alternative habitats that may fail to meet their ecological needs. Temperature, moisture, and cover dictate the presence and absence of different types of prey sought by snakes. Displaced snakes may impose uncompensated pressures to existing communities by competing with resident snakes.

Determination of species' habitat preferences is crucial for species conservation. Land development, harvest of forest resources, and pollution occur across the American landscape. Destruction of snake habitat has jeopardized the viability of some snake populations, especially those of ecologically specialized species (Ashton and Ashton 1981).

Minimal research has been performed to investigate the relationship between thermal biology and foraging mode; however, the effects of body size on rates of cooling in reptiles has been addressed by Peters (1983) and Ayers and Shine (1997). The proposed connection may be of critical value to the biology of ectothermic predators (Ayers and Shine 1997). Thermal inertia (via body size and postural adjustments) has been considered to play a major role in the ability of large heavy-bodied snakes to feed

on nocturnal prey (Slip and Shine 1988c). Microhabitat selection and thermal inertia regulate a snake's internal temperature, which ultimately affects its activity (i.e. foraging). Ectotherms that are able to adjust their rates of heat exchange with their environment exhibit fascinating thermal influences on foraging efficiency. The extent of regulation in individuals with larger body size is likely highest due to physiological modification and behavioral control over their rate of heat transfer with the environment (i.e., thermal inertia) (Ayers and Shine 1997, Grigg *et al.* 1979).

CHAPTER II

METHODS

Study Area

The study area was a 1295 hectare ranch (Triple J) near the town of Somerville, Texas (30.3° N 96.6° W) in the southern post oak savannah region of East-central Texas. Triple J Ranch lies between the East and West Cross Timbers of the Texan province, which coincides with the demarcation of many herpofaunal ranges. The essentially sandy soils of this region support post oak-blackjack oak-hickory savannahs scattered among tallgrass prairies. Rivers, creeks, and associated riparian belts of the region provide valuable snake habitat as well as migratory corridors (Werler and Dixon 2000). Triple J Ranch, located in Burleson County, is approximately ten miles west of the Brazos River and less than one mile north of Yegua Creek. The ranch is coursed with perennial, intermittent, and ephemeral creeks providing ample lotic systems for semi-aquatic and aquatic snakes. Twenty-eight lakes and ponds ranging from 0.10- 3.70 hectares are located on the property. This region receives 76 - 102 cm of rainfall per year and is characterized by hot, mildly wet summers and cold, dry winters. Extreme temperatures for this region range from -6.6°C in the winter to 40.5°C in the summer. April-August 2005, the mean temperature ranged from 19.4°C - 29.2°C (NWS 2006). Rains are sporadic and usually occur most heavily during January and February and from June to August (NWS 2006). Very little rain falls between March and May. Rainfall is variable, and July and August received the most rain during the study.

The post oak savannah of East-central Texas is within the Texan biotic province, first described by L.R. Dice (1943), and stretches from the Red River south to the Gulf Coast (Fig. 1). The Kansan, Balconian, and Tamaulipan provinces of grassy, rocky, and semi-arid nature respectively border the Texan province on the west whereas the eastern fringe abuts the moist pine-oak forests of the Austroriparian province (Werler and Dixon 2000). Due to its ecotonal nature, the Texan province sustains a fusion of diverse plant and animal species typical of the Tamaulipan and Austroriparian provinces.

Map of Texas

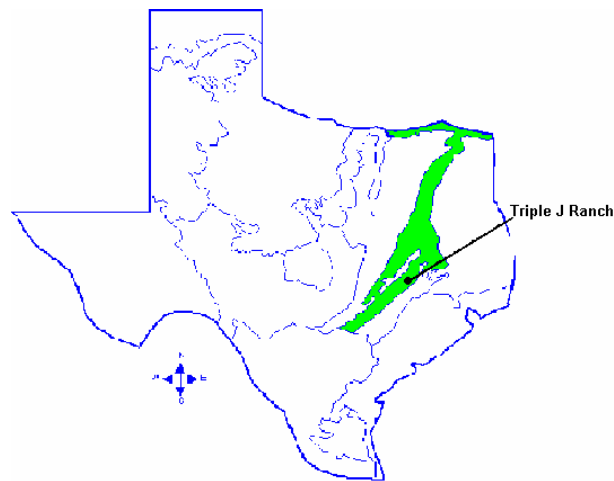


Fig. 1. Map of Texas showing the location of Triple J Ranch within the southern post oak savannah ecological region.

Post oaks (*Quercus stellata*) dominate the study area, with the exception being the riparian forests that consist mainly of water oaks (*Q. nigra*). Four types of habitat were sampled: upland woodland, prairie, riparian forest, and ponds. The upland woodland is characterized by post oak, blackjack oak (*Q. marilandica*), live oak (*Q. virginiana*), cedar elm (*Ulmus crassifolia*), sugarberry (*Celtis laevigata*), eastern juniper (*Juniperus virginiana*), and yaupon (*Ilex vomitoria*). Prairie habitat consists mainly of Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), Texas wintergrass (*Stipa leucotricha*), little bluestem (*Schizachyrium scoparium*), Johnson grass (*Sorghum halepense*), wild indigo (*Baptisia* spp.), senna (*Cassia* spp.), croton (*Croton* spp.), prairie-clover (*Petalostemon* spp.), tick-clover (*Desmodium* spp.), and sporadic post oak. Typical woody vegetation in the riparian forest includes water oak (*Q. nigra*), live oak (*Q. virginiana*), river birch (*Betula nigra*), Pecan (*Carya illinoensis*), American elm (*U. americana*), and winged elm (*U. alata*). Understory vegetation throughout the study area is dominated by yaupon (*Ilex vomitoria*), but also includes American beautyberry (*Callicarpa americana*), honey locust (*Gleditsia tricanthos*), greenbriar (*Smilax bonanox*), and poison ivy (*Toxicodendron radicans*). Pond habitat is comprised of several types of aquatic vegetation including water leaf (*Hydrolea* spp.), alligator weed (*Alternanthera philoxeroides*), smartweed (*Polygonum* spp.), American lotus (*Nelumbo lutea*), cattail (*Typha* spp.), water primrose (*Ludwigia hexapetala*), water shield (*Brasenia schreberi*), water lily (*Nymphaea* spp.), coontail (*Ceratophyllum demersum*), muskweed (*Chara* spp.), and filamentous algae (*Oedogonium* spp.). Pond habitats are

surrounded by rattlebush (*Sesbania drummondii*), greenbriar, yaupon, black willow (*Salix nigra*), and post oaks.

Capture, Handling, and Data Collection

Surveys were conducted for snake species from April – August 2005, following procedures outlined by Texas Parks and Wildlife (Simpson *et al.* 1996) and adapted for specific habitats on the Triple J Ranch. Snakes were sampled using minnow traps, linear drift-fence arrays, time-constrained searches, timed nocturnal road searches, and incidental hand captures. All nonvenomous specimens captured were identified to species, measured from snout to vent (SVL) in centimeters, sexed by use of high quality surgical stainless steel ball-tipped sexing probes, recorded for time of capture, and digitally photographed. Venomous specimens were identified to species, measured for total length (TL) in centimeters (via box or bucket with graduated side(s)), recorded for time of capture, and digitally photographed. Converting TL to SVL was made possible by the Texas Cooperative Wildlife Collection (TCWC) where 20 specimens (10 male; 10 female) of *A. contortrix* were measured for TL and tail length; tail length/TL for each individual yielded proportion of TL comprised of tail for each individual and sex; a mean proportion of tail length to TL for each sex was calculated. Approximate SVL (TL – tail length=SVL) was derived for each *A. contortrix* sampled from these data. Environmental data were recorded for each day consisting of high, low, and mean temperature, percent cloud cover, barometric pressure, wind (mph), and precipitation. Previous and approaching rainfall events were also noted. All traps were monitored

individually for amount of time set. Water snakes (*Nerodia*) and some ribbon snakes (*Thamnophis*) were trapped using Gee Minnow Traps (Forestry Suppliers, Inc., Jackson, Mississippi) placed along shorelines of six ponds ranging from 0.24 - 3.7 hectares in area. Traps at pond sites were checked twice a day (i.e. once at mid-morning and once at late-afternoon). Six linear drift-fence arrays were constructed with a funnel trap on both sides of the center and one on each end (four traps per array). Sites for drift-fence arrays were selected according to terrestrial habitat, i.e. upland woodland (3), prairie (1), riparian forest (2). Drift-fence arrays were run 3-7 days and nights per sampling period and were checked for captured animals twice a day. Capture data from pond traps and drift fence arrays were expressed as captures per hour. Time-constrained searches were performed for one hour at a time in each specified habitat by 1-4 observers at a time. The frequency of time-constrained searches decreased from the beginning of the study towards the end due to recurrent low productivity. The few time-constrained captures were expressed as number of snake captures per person-minute. Timed nocturnal road searches were conducted every sampling night and lasted from half an hour before sundown to approximately two hours after dark. Road cruising data were expressed by number of captures per minute despite the very low number of captures via this method. Incidental hand captures were most frequently done in transit among sites.

Statistical Analyses

Linear regression was used to analyze the relationship between temperature and body size, to test the theory that larger snakes exhibit slower cooling rates than their

smaller counterparts; thus, enabling larger individuals to forage at lower temperatures while smaller individuals are largely inactive. A decreasing slope would provide support for this theory. Analysis of categorical data (chi-square) was used to test for an association between habitat type and species richness. Total number of species was estimated for trap-captured species per month, based on adjustment for sample abundances with a first order jackknife estimator (Heltshe and Forrester 1983).

CHAPTER III

RESULTS

All combined methods of sampling resulted in 145 captures of 15 species (Table 1). Based on published distributional information and county records, at least 11 additional snake species are expected to occur on the property (TCWC 1998). Pond trap captures accounted for 23 (15.9%) of the total captures and consisted of 4 species (Table 1). Drift fence arrays yielded the most individuals as well as the most species-rich samples of the study with 74 (51.0%) individuals comprising 14 species (Table 1). Time constrained searches and timed nocturnal road cruises produced very few captures together totaling 13 (8.9%) individuals which amounted to only 4 species. The timber rattlesnake (*Crotalus horridus*), the only state-threatened species verified on Triple J Ranch, was documented by incidental encounters.

Although 15 species were sampled, 71% of the specimens represented only 5 species (Table 1). The plain-bellied water snake (*Nerodia erythrogaster*), eastern coachwhip (*Masticophis flagellum*), and western ribbon snake (*Thamnophis proximus*) had the highest relative abundances, followed by the southern copperhead (*Agkistrodon contortrix*) and Texas rat snake (*Elaphe obsoleta*). The brown snake (*Storeria dekayi*) and Texas coral snake (*Micrurus tener*) each were encountered only once during the study. The brown snake was one of only 4 snakes found beneath corrugated tin cover.

TABLE 1—Snake species captured by month for Triple J Ranch, Somerville, Texas, during April—August 2005

Species	2006					Total	%
	April	May	June	July	August		
Colubridae							
Colubrinae							
<i>Coluber constrictor</i>	2		2	1		5	3.7
<i>Elaphe obsoleta</i>	9	3	1	1		14	10.3
<i>Lampropeltis getula</i>		1		1		2	1.5
<i>Lampropeltis triangulum</i>	1	1	1		1	4	2.9
<i>Storeria dekayi</i>	1					1	0.7
<i>Thamnophis proximus</i>	9	4	9		1	23	16.9
<i>Masticophis flagellum</i>	10	4	7	2	1	24	17.6
Natricinae							
<i>Nerodia erythrogaster</i>	13	4	4	3	1	25	18.5
<i>Nerodia rhombifer</i>	2		2		1	5	3.7
<i>Nerodia fasciata</i>	2		1	1		4	2.9
Xenopodinae							
<i>Heterodon platirhinos</i>	3	1				4	2.9
Elapidae							
<i>Micrurus tener</i>			1			1	0.7
Viperidae							
Crotalinae							
<i>Agkistrodon contortrix</i>	6	2	5	3	1	17	12.5
<i>Agkistrodon piscivorus</i>			3	1	1	5	3.7
<i>Crotalus horridus</i>			1		1	2	1.5
Total	58	20	37	13	8	136	
%	42.6	14.7	27.2	9.6	5.9		

Species richness and abundances were determined by catch per unit effort (CPUE) for ponds, riparian forests, upland woodlands, and prairies. Unit of effort was one hour. Among the 4 habitat types studied, 74 individuals (76.3% of total site captures) constituting 13 species were sampled within the upland woodlands (41.2%) and riparian forests (35.1%). Pond sites yielded 16 individuals (16.5%) consisting of 3 species, whereas the prairie site produced only 7 (7.2%) individuals but comprised 5 species. The results of a contingency table X^2 statistical test rendered a chi-square value of 9.03 and a probability of 0.701. Total species estimate for trap-captured species per month was 11.0 (first order jackknife). Catch per hour for each habitat type was 0.0121 for upland woodlands, 0.0087 for riparian forests, 0.0035 for ponds, and 0.0107 for prairies. Incidental captures in addition to standardized trap captures within each given habitat resulted in the following: upland woodlands totaling 53 individuals (39.9%), riparian forests totaling 42 individuals (31.6%), ponds totaling 23 individuals (17.3 %), and prairies totaling 15 individuals (11.3%). There was no significant statistical association among habitat and month at the study site.

Linear regression was used to determine the relationship between SVL and ambient temperature (during capture) of the five most common species: *A. contortrix*, *E. obsoleta*, *M. flagellum*, *N. erythrogaster*, and *T. proximus* (Fig. 2-6). Average SVL of each month (i.e., April-August) for each of the five abundant species is depicted below (Fig. 7 & 8) with the standard deviations of each. Fifty percent of all snakes captured over 80 cm were caught on days with a mean temperature below or equal to 23.8 °C.

Southern Copperhead

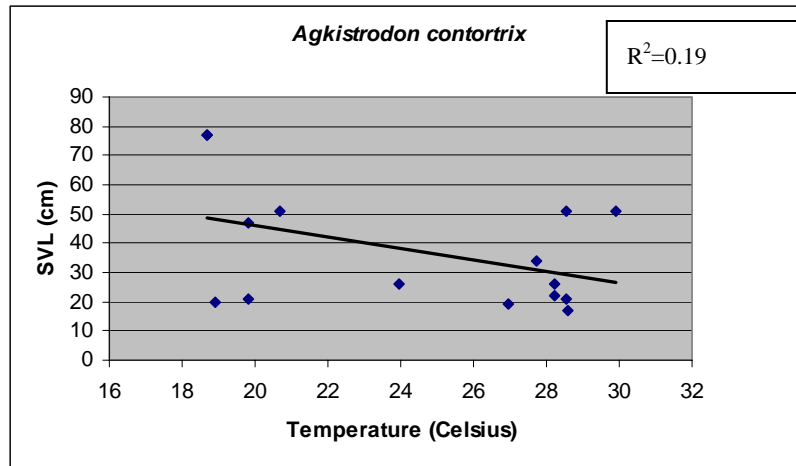


Fig. 2. Linear regression relationship between snout-to-vent length and temperature for southern copperhead (*Agkistrodon contortrix*).

Texas Rat Snake

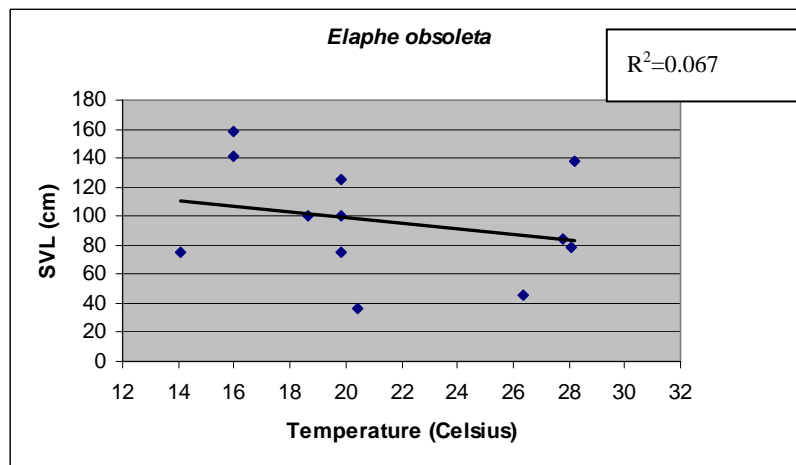


Fig. 3. Linear regression relationship between snout-to-vent length and temperature for Texas rat snake (*Elaphe obsoleta*).

Eastern Coachwhip

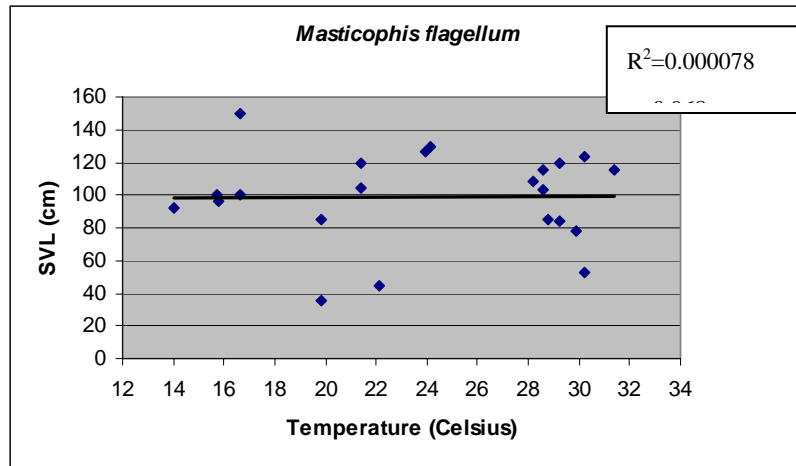


Fig. 4. Linear regression relationship between snout-to-vent length and temperature for eastern coachwhip (*Masticophis flagellum*).

Plain-bellied Water Snake

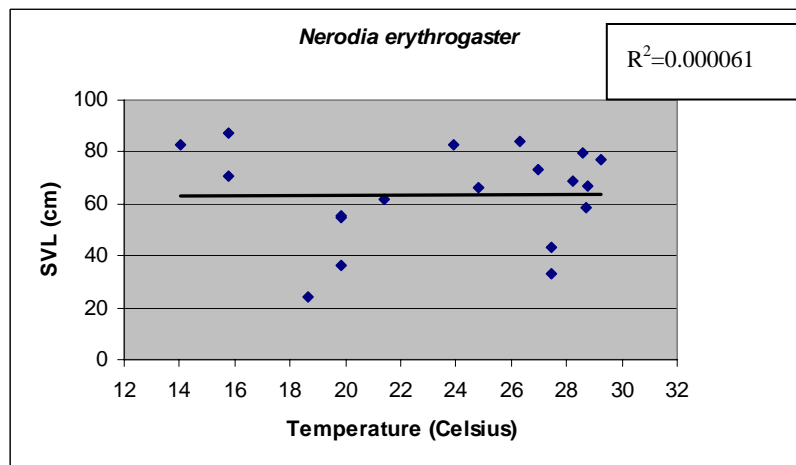


Fig. 5. Linear regression relationship between snout-to-vent length and temperature for plain-bellied water snake (*Nerodia erythrogaster*).

Western Ribbon Snake

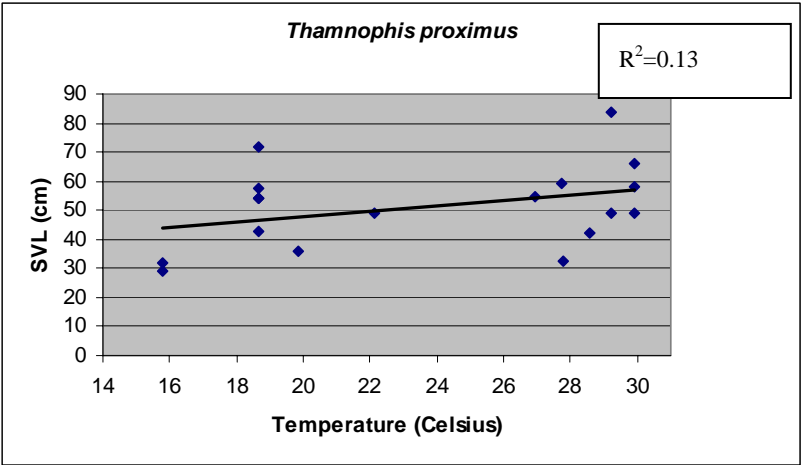


Fig. 6. Linear regression relationship between snout-to-vent length and temperature for western ribbon snake (*Thamnophis proximus*).

Species Richness per Habitat Type

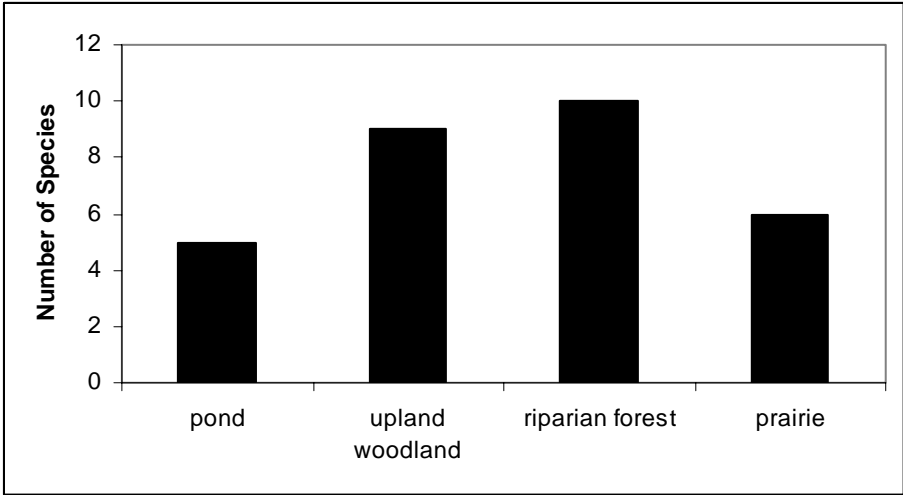


Fig. 7. Bar graph presenting species richness per habitat type.

Average Snake Length per Month

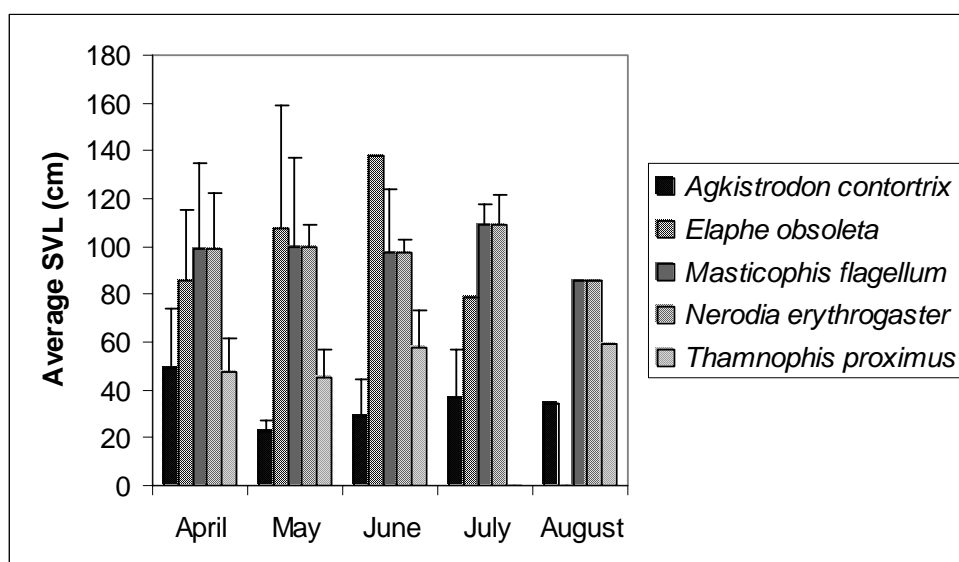


Fig. 8. Clustered column graph depicting average snout-to-vent length and standard deviation for each month during the study for the five most abundant species captured.

CHAPTER IV

CONCLUSION

Apparent affinities for specific habitat types were observed in 5 species. The plain-bellied water snake (*Nerodia erythrogaster*), the diamondback water snake (*N. rhombifer*), and the southern water snake (*N. fasciata*) were only found in aquatic habitats; moreover, *N. fasciata* was found only in proximity to the only perennial creek on the ranch (riparian forest). The cottonmouth (*Agkistrodon piscivorus*) was only found within riparian forests. *Crotalus horridus* is historically known to inhabit dry ridges with oak-hickory forests scattered with open areas (Minton 1972), "deciduous forest, especially along hilltop rock outcrops in thick woods" (Fitch 1958), and "hardwood forests of the type found in many river bottoms" (Cook 1943). Likely due to increased human development of upland habitat, *C. horridus* has been documented in low riparian areas more frequently than historically recorded; however, in the southeastern extent of its range, *C. horridus* thrives within "swampy areas and floodplains" (Mount 1975), "wet pine flatwoods, river bottoms and hydric hammocks" (Ashton and Ashton 1981), and "hardwood forests and cane fields of alluvial plain and hill country" (Dundee and Rossman 1989). Over 10 sightings of *C. horridus* were noted through August to October (2005) on the property (2 documented during study). The period of highest observed incidence (August-October) may likely coincide with the breeding season of this species in the area. *C. horridus* is believed to become active as early as April. As they emerge

from their dens, they are lethargic and feed very little; however, as temperatures begin to climb, males gradually enliven and disperse in search of pheromone-trailing females (Werler and Dixon 2000). Every individual, except for two, was encountered on or near a road (i.e., caliche, dirt, asphalt). The other two were found away from roads; one in upland woodland and the other in riparian forest.

The other ten species (66% of total species sampled) occurred in 3 or more habitat types suggesting a generalist lifestyle. *Masticophis flagellum* and *Thamnophis proximus* were found in all habitat types. *T. proximus* was conspicuously the most opportunistic species witnessed during the study; it was observed feeding on a green treefrog (*Hyla cinerea*) ~5 m high in a post oak. *T. proximus* frequently was spotted in and adjacent to permanent water. *M. flagellum* was common throughout all three terrestrial habitats but was seldom encountered within pond habitat. *Elaphe obsoleta* was often found basking at the water's edge and swimming across open water. *T. proximus*, *M. flagellum*, and *E. obsoleta* tended to seek and scale trees of any size to evade capture. *Agkistrodon contortrix* was the most abundant and widespread viper sampled. Its preference appeared to be upland woodland, where it was found 60% of the time, and riparian forest and prairie, where it was found 25% and 15% of the time respectively.

The trend indicating that larger individuals are active at lower temperatures was not statistically significant in this study. Due to small sample sizes, biological significance could not be determined assuredly. I interpret this to mean that season (i.e., temperature) did not influence the number of species or snakes found in different

habitats. The community is made up of many habitat generalists; perhaps the snake species' niches vary more by diet and daily activity than by major habitat type or season.

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